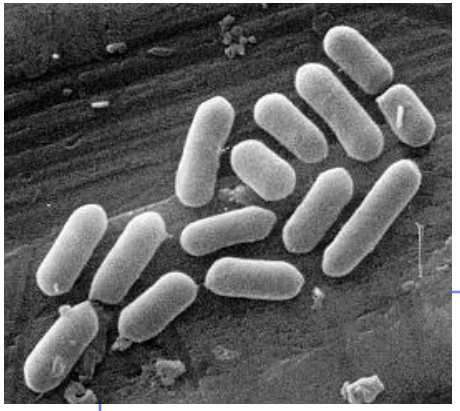
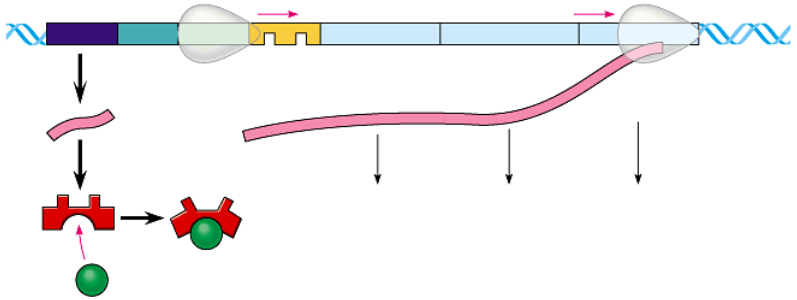
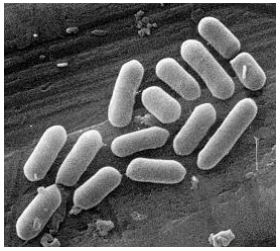


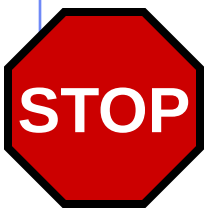


Control of Prokaryotic (Bacterial) Genes

Bacterial metabolism

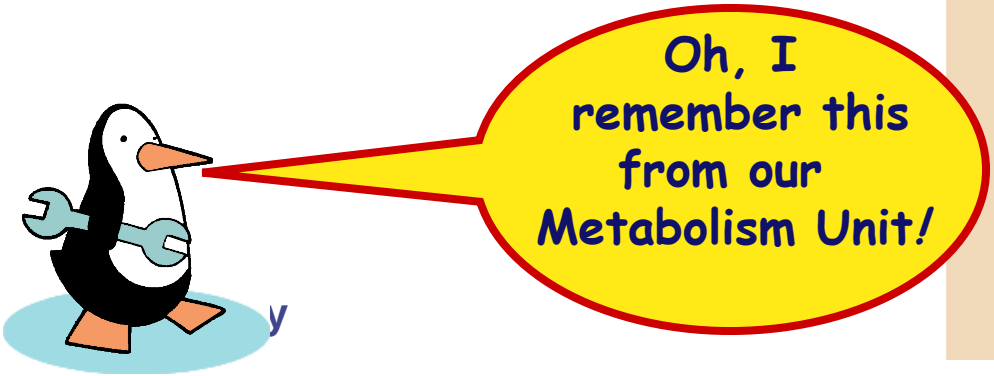


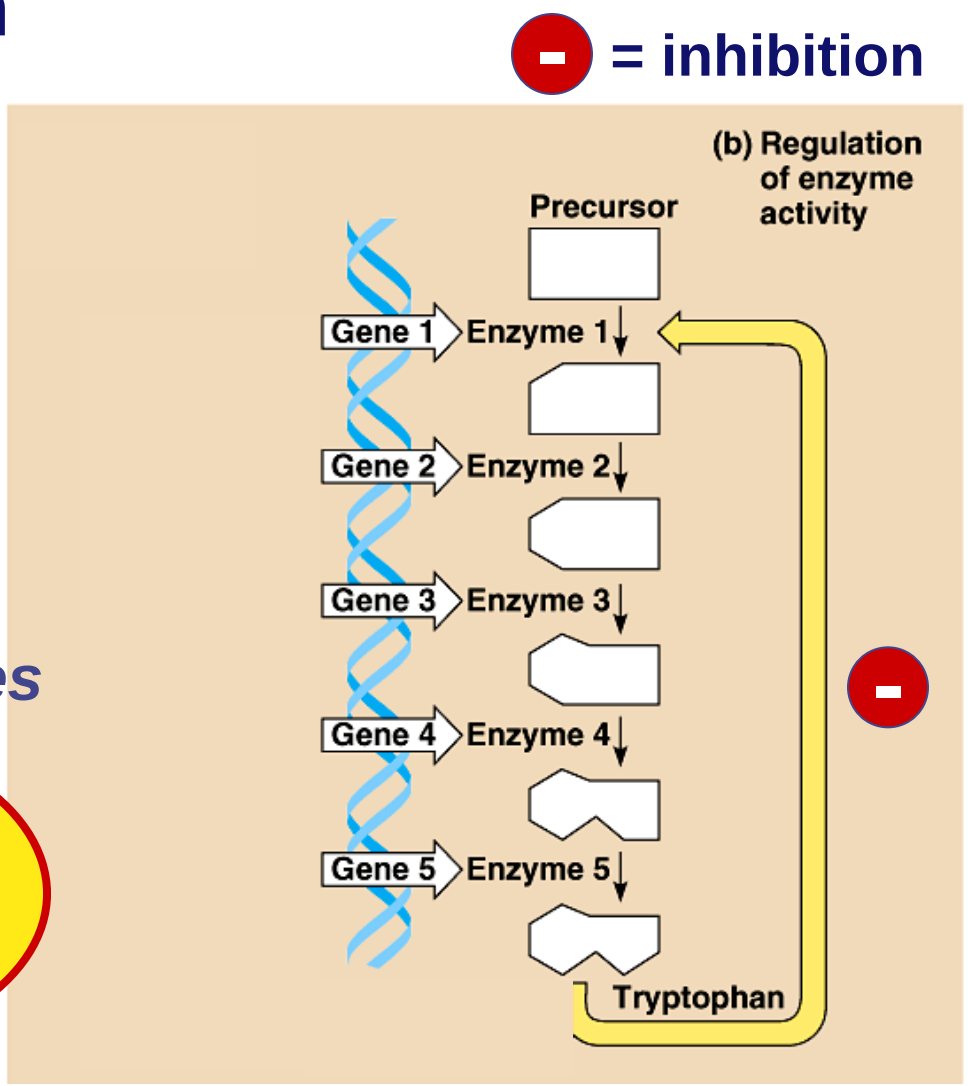
- Bacteria need to respond quickly to changes in their environment
  - if they have enough of a product, need to stop production
    - why? waste of energy to produce more
    - how? stop production of enzymes for synthesis
  - if they find new food/energy source, need to utilize it quickly
    - why? metabolism, growth, reproduction
    - how? start production of enzymes for digestion



Remember Regulating Metabolism?

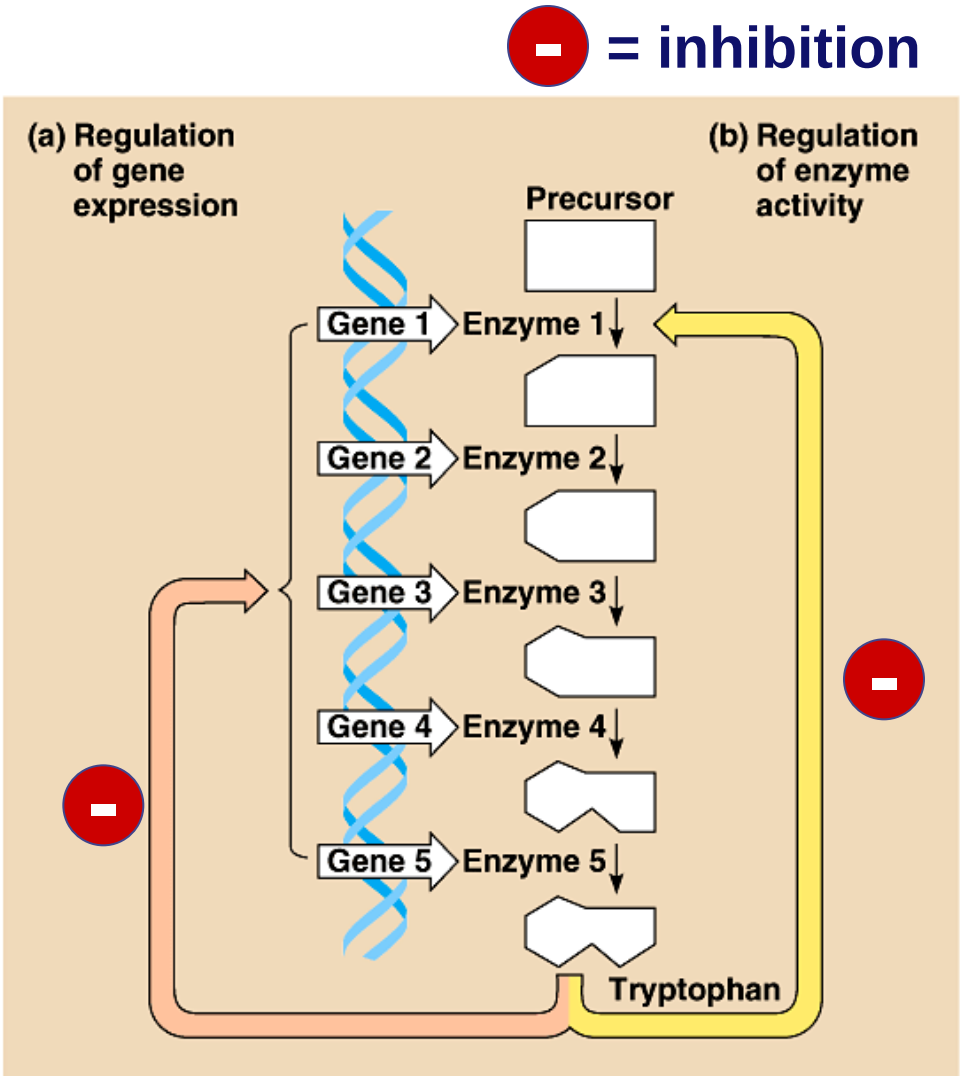
- **Feedback inhibition**
  - product acts as an allosteric inhibitor of 1st enzyme in tryptophan pathway
  - *but this is wasteful production of enzymes*



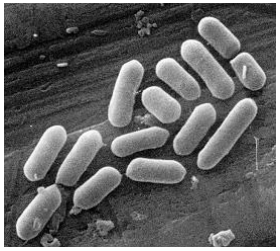


Different way to Regulate Metabolism

- **Gene regulation**
  - instead of blocking enzyme function, block transcription of genes for all enzymes in tryptophan pathway
    - saves energy by not wasting it on unnecessary protein synthesis



Gene regulation in bacteria



- Cells vary amount of specific enzymes by regulating gene transcription
  - turn genes on or turn genes off
    - turn genes OFF example

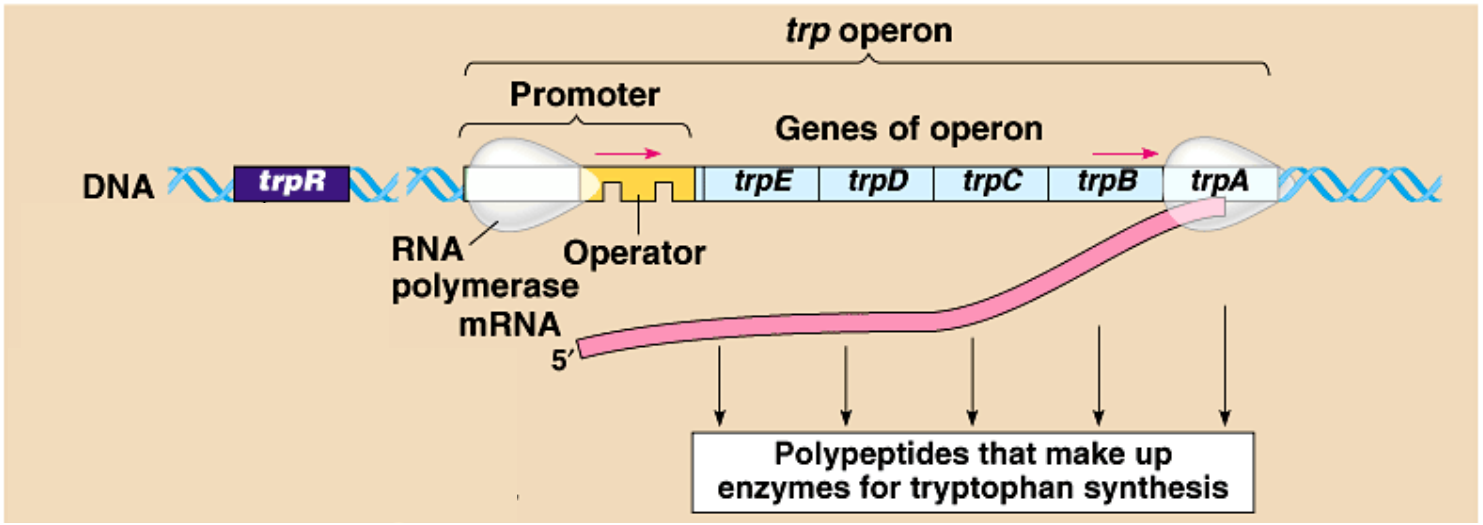
if bacterium has enough tryptophan then it doesn't need to make enzymes used to build tryptophan

    - turn genes ON example

if bacterium encounters new sugar (energy source), like lactose, then it needs to start making enzymes used to digest lactose

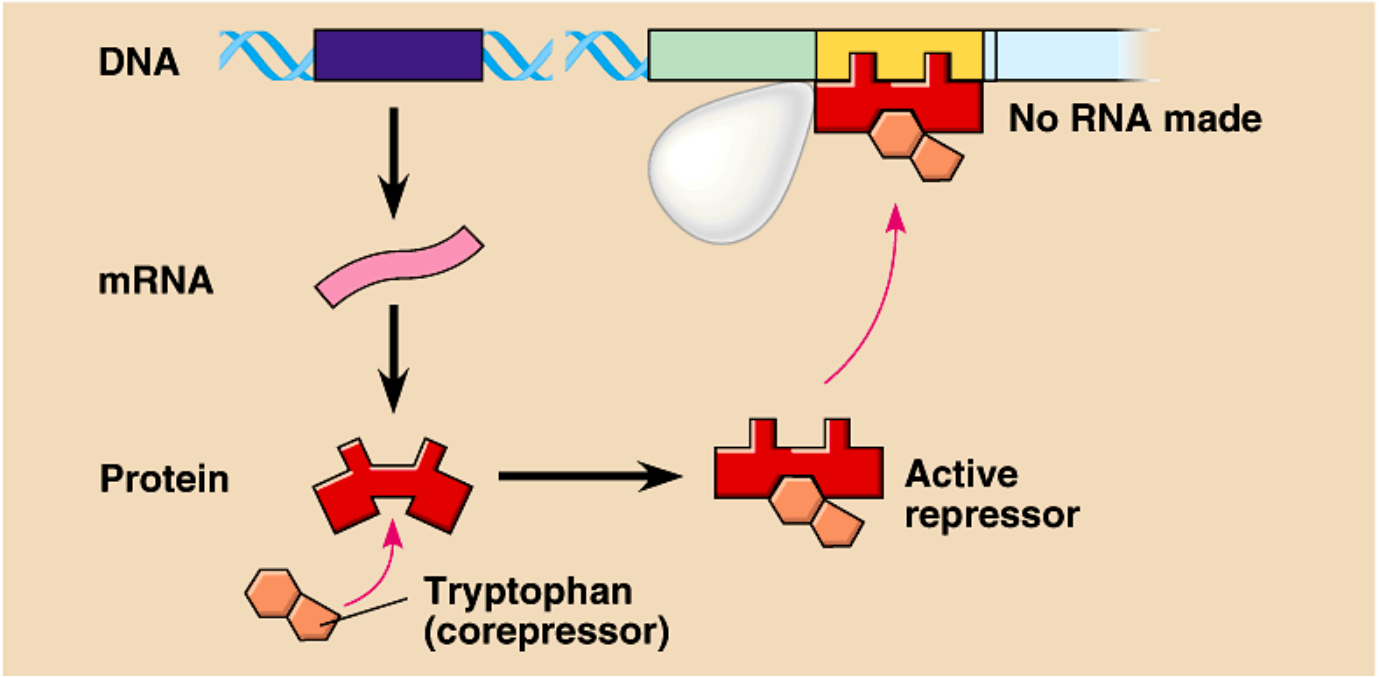
Bacteria group genes together

- **Operon**
  - genes grouped together with related functions
    - example: all enzymes in a metabolic pathway
  - promoter = RNA polymerase binding site
    - single promoter controls transcription of all genes in operon
    - transcribed as one unit & a single mRNA is made
  - operator = DNA binding site of repressor protein



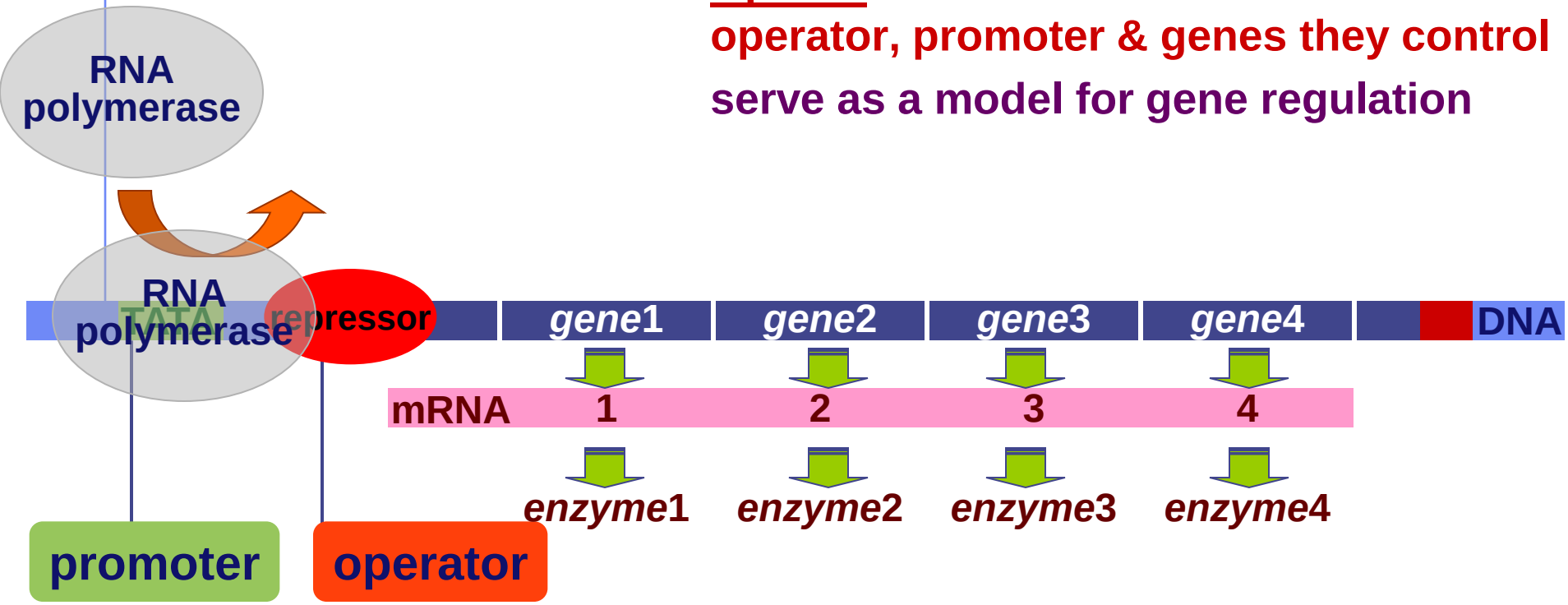
So how can these genes be turned off?

- **Repressor protein**
  - binds to DNA at operator site
  - blocking RNA polymerase
  - blocks transcription



Operon model

Operon:
operator, promoter & genes they control
serve as a model for gene regulation



Repressor protein turns off gene by blocking RNA polymerase binding site.

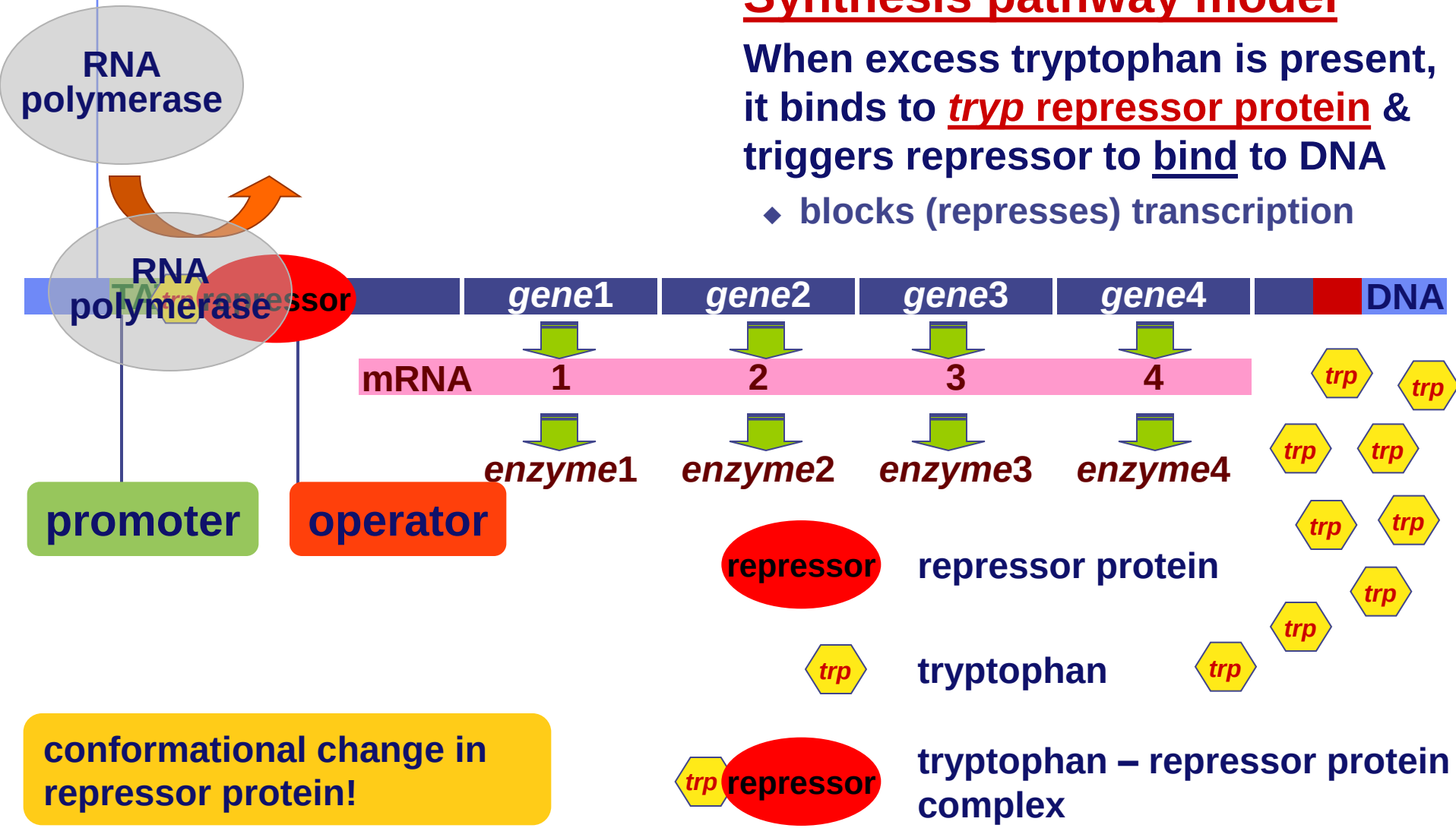
repressor = repressor protein

Repressible operon: tryptophan

Synthesis pathway model

When excess tryptophan is present, it binds to *tryp* repressor protein & triggers repressor to bind to DNA

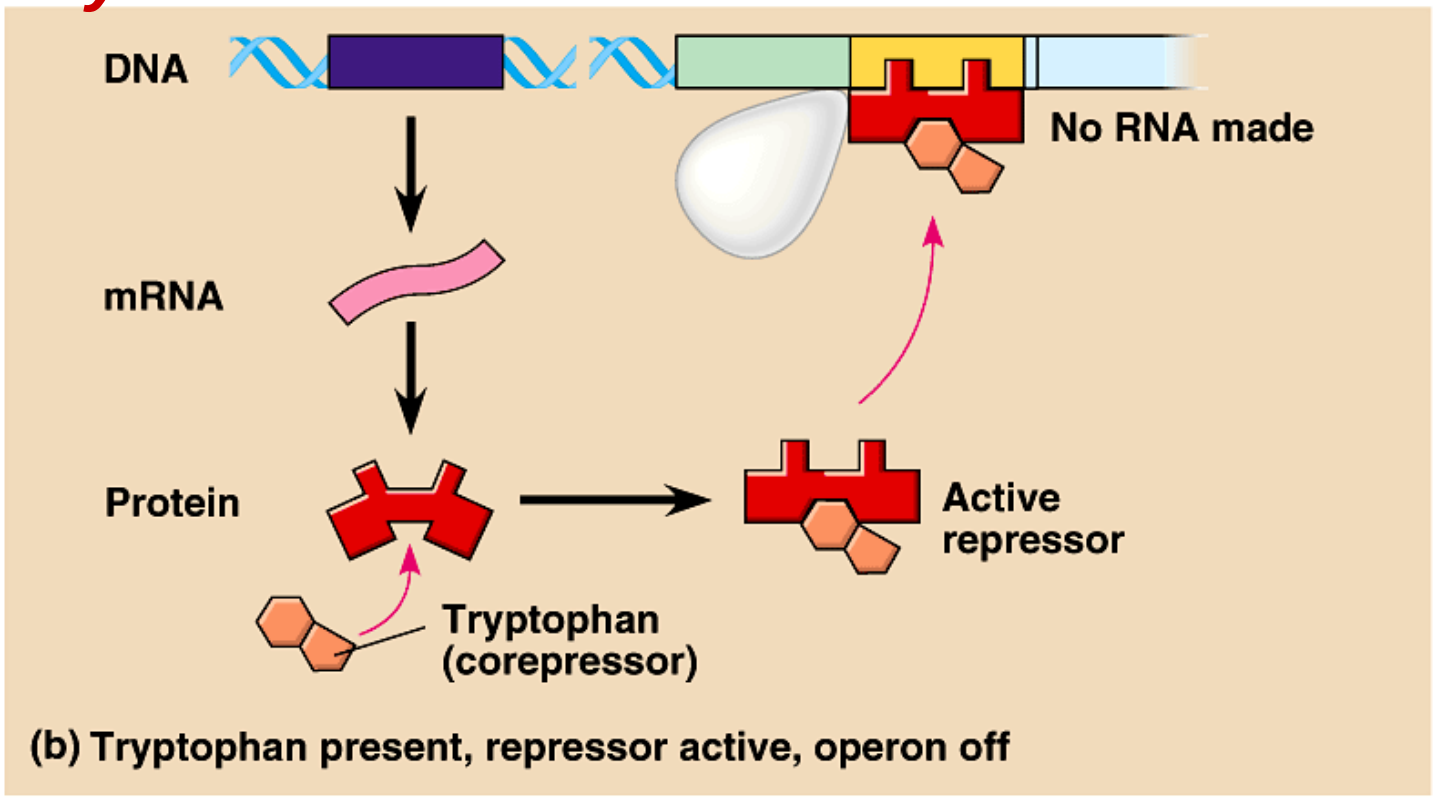
- blocks (represses) transcription



Tryptophan operon

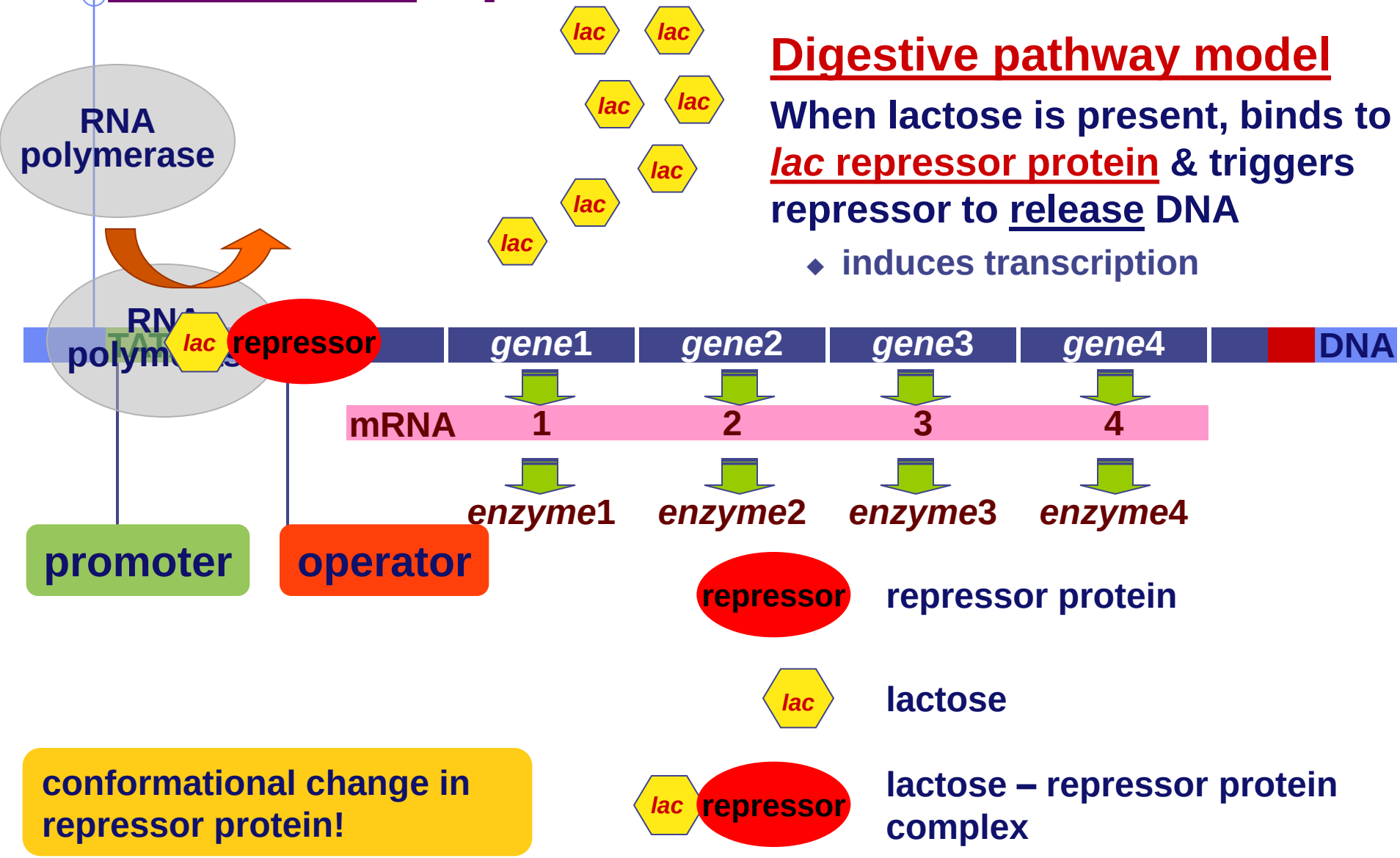
What happens when tryptophan is present?

Don't need to make tryptophan-building enzymes



Tryptophan is allosteric regulator of repressor protein

Inducible operon: lactose



Digestive pathway model

When lactose is present, binds to *lac* repressor protein & triggers repressor to release DNA

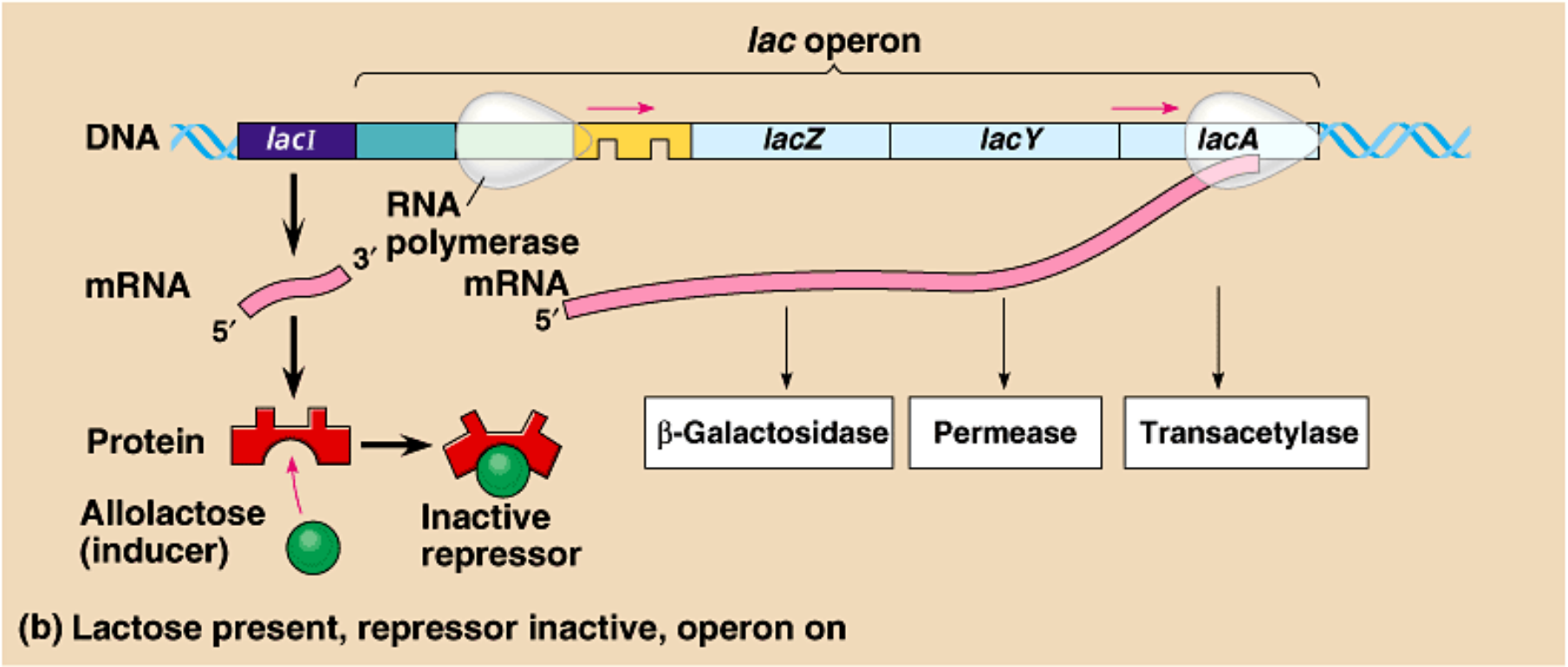
- induces transcription

conformational change in repressor protein!

Lactose operon

What happens when lactose is present?

Need to make lactose-digesting enzymes

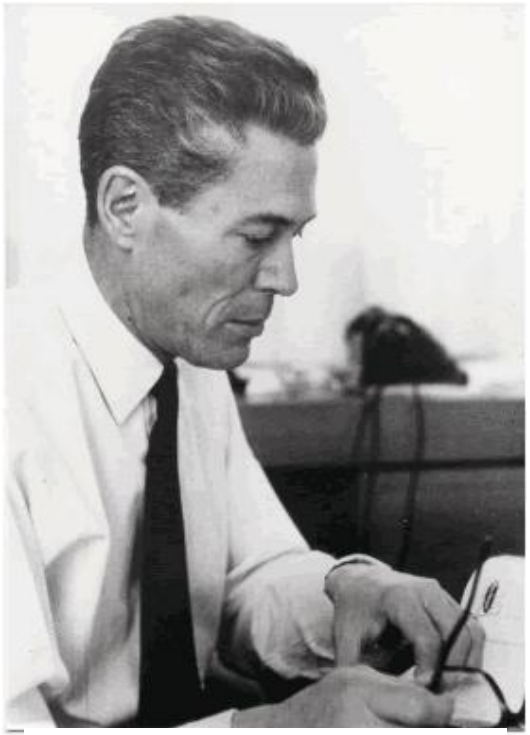


Lactose is allosteric regulator of repressor protein

Jacob & Monod: *lac* Operon

1961 | 1965

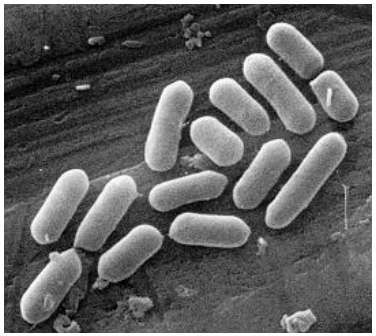
- Francois Jacob & Jacques Monod
  - first to describe operon system
  - coined the phrase “operon”



Jacques Monod

Francois Jacob

Operon summary



- **Repressible operon**
  - usually functions in **anabolic** pathways
    - **synthesizing** end products
  - when end product is present in excess, cell allocates resources to other uses
- **Inducible operon**
  - usually functions in **catabolic** pathways,
    - **digesting** nutrients to simpler molecules
  - produce enzymes only when nutrient is available
    - cell avoids making proteins that have nothing to do, cell allocates resources to other uses

Don’t be repressed!

How can I induce you to ask Questions?